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A method of investigating the action of ultraviolet rays on bacteria.

By

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The influence of light rays especially of ultraviolet rays on bacteria has long since been studied by many investigators. Their bactericidal action[1], the inhibitory effect on the growth of bacteria[2], the metamorphosing action[3] and the destructive action on the virulency of pathogenic germs[4] have been established.

In order to study these effects more closely, monochromatic lights should be used as the source of light, and its effects should be examined separately for every light of different wave length[5]. Recently Hertel[6] determined the bactericidal limits of wave lengths of light, by

1 A. Downes & Th. P. Blunt, Proc. R. Soc., London, **26**, 488 (1877).
E. Duclaux, C.R., **100**, 184 (1885).
H. Buchner, Arch. f, Hygiene, **17**, 179 (1893).
M. Ward. Proc. R. Soc., Londen, **52**, 393 (1892–3).
H. Thiele & K. Wolf, Arch. f. Hygiene, **57**, 29 (1906).
A. Keller, Centralbl f. Bakteriol., Ref., **40**, 186 (1907).
J. Malgat, Centralbl. f. Bakteriol., Ref., **44**, 122 (1909).
R. Lemoine, Centralbl. f. Bakteriol., Ref., **50**, 286 (1911).
W. Hausmann, Centralbl. f. Bakteriol., Ref., **51**, 618 (1912).
E. Jacobsthal &. F. Tamm, Münchener med. Wochenschr., 61 Jg., 2324 (1914).
H. S. Newcomer, J. Exp. Med., **26**, 841 (1917).
Miramond de Laroquette, Annales de l'institut Pasteur, **32**, 170 (1918).

2 S. Arloing, C. R., **100**, 378 (1885).

3 V. Henri, C. R., **158**, 1032 (1914),
Ibid., **159**, 340 (1914),
Mrs. V. Henri, C. R. **159**, 413 (1914).

4 G. Orsi, Centralbl. f. Bakteriol., Orig., **43**, 846 (1907).

5 H. Strebel, Deutsch. med. Wochenschr., **27** Jg., 69 & 87 (1901).
E. Hertel, Zs. f. allg. Physiol., **4**, 1 (1904).
E. Gill, Phil. Mag., **19**, 290 (1910).
V. Henri & his wife, C. R., **155**, 315 (1912).

6 E. Hertel, Zs. f. allg. Physiol., **5**, 95 (1905).

projecting various parts of the spectrum, upon the inoculated culture-medium separately. The determination of intensities of bactericidal power of every part of the spectrum was done by comparing the numbers of living bacteria in the physiological saline water suspension before and after its exposure. This method is, however, not adequate, because it is quite difficult to make exact count of the number of bacteria, and almost impossible to illuminate by a monochromatic light.

To avoid these disadvantages, a quartz spectrograph was employed in the present experiment, and the photographic plate was replaced by a thin culture-medium inoculated on a glass plate with a certain kind of bacteria, and different exposures were given on one plate one above the other. The part of the culture-medium, wherein the bacteria were killed, became transparent after incubation, while the remaining part got semitransparent by their growth, thus the image of spectrum lines being finely impressed on a culture-medium. From this the limits of wave lengths of light where the action ceases were determined for given exposures; and a curve showing the relation between bactericidal limits for different exposures was plotted. This curve we shall call the "bactericidal curve," and it somewhat resembles the absorption curves in spectroscopy.

This method of obtaining the "bactericidal curve" was already reported by the writer at the annual general meeting of the "Kyoto Medical Association" (Kyoto Igaku Kai) held in November, 1917, and a short abstract was given in its journal[1]. After the publication of this, the writer noticed a similar work by Browning and Russ[2], but he has not yet been able to obtain their original paper.

Method of Experiments.

A quartz spectrograph of size A made by Hilger was employed, and this was placed in such a position as to keep the plate holder horizontal. As the source of light, a carbon arc, iron arc and condensed sparks of iron and cadmium excited by the Blitzen transformer of 1/4 kw, were used.

The inoculated culture-medium of bacteria was prepared in the following manner. A glass plate of suitable size was held horizontally,

[1] T. Mashimo, Kyoto Igaku Kai Zassi, **15** (1918).

[2] C. H. Browning & S. Russ, Proc. R. Soc., London, **90**, B, 107 (1918). Cf. Nature, **101**, 112 (1918), cf. H. S. Newcomer, J. Exp. Med., **26**, 841 (1917).

and a metal frame of similar shape but of somewhat smaller dimensions was placed just on it. As the culture-medium agar agar was used. After being melted by heating gently, a certain amount of it was poured on the glass plate until the medium got a thickness of about three mm. After fixing it, the bacteria-suspension in physiological saline solution was smeared on its surface and then it was brought to a suitable degree of moisture, sufficient to prevent the dislocation of bacteria by their own motion, but keeping them alive. The metal frame was then taken off, and the plate thus prepared was put in the plate-holder horizontally. The bacteria used were as follows :—Bacillus coli communis, B. subtilis, B. mycoides, B. pyocyaneus, Sarcina, Micrococus pyogenes, Vibrio.

After exposures being given, the preparation was put in an incubator and it was kept there 12–24 hours long to favour the growth of bacteria. The transparent image of spectral lines then appeared clearly on a somewhat white background, and this was next put in a formalin-vapour to fix it.

As an illustration one of reproductions corresponding to the table 3 is shown in Fig. 1, and the bactericidal curve determined from it is given in Fig. 2.

Results of Experiments.

The results of the experiments are given in the following tables.

A. Bactericidal curves.

TABLE 1.

Germ : Bacillus coli communis.
Culture-medium : Agar agar.
Source of light : Condensed spark of iron.

Time of exposure in minutes	Upper limit of wave length having bactericidal action	Lower limit of wave length having bactericidal action
1	2418 ÅU	2749 ÅU
3	2327 „	2749 „
6	2067 „	2749 „
12	2067 „	2784 „
15	1913 „	2841 „
20	1895 „	2878 „
40	1895 „	2878 „
80	1877 „	2948 „

TABLE 2.

Germ: Bacillus subtilis.
Culture-medium: Agar agar.
Source of light: Condensed spark of iron.

Time of exposure in minutes	Upper limit of wave length having bactericidal action	Lower limit of wave length having bactericidal action
1	2382 ÅU	2749 ÅU
2	2382 „	2749 „
4	2348 „	2749 „
6	2348 „	2749 „
8	2327 „	2784 „
10	2250 „	2841 „
15	2085 „	2841 „
20	2067 „	2841 „
41	2067 „	2874 „
80	2000 „	2874 „

TABLE 3.

Germ: Bacillus mycoides.
Culture-medium: Agar agar.
Source of light: Condensed spark of iron.

Time of exposure in minutes	Upper limit of wave length having bactericidal action	Lower limit of wave length having bactericidal action
$\frac{1}{4}$	2749 ÅU	2749 ÅU
$\frac{1}{2}$	2749 „	2413 „
1	2749 „	2327 „
2	2841 „	2250 „
3	2841 „	2067 „
4	2841 „	1990 „
5	2841 „	1913 „
6	2841 „	1895 „
8	2874 „	1895 „
10	2874 „	1887 „
20	2948 „	1874 „
40	2986 „	1859 „

TABLE 4.

Germ: Bacillus pyocyaneus.
Culture-medium: Agar agar.
Source of light: Condensed spark of iron.

Time of exposure in minutes	Upper limit of wave length having bactericidal action	Lower limit of wave length having bactericidal action
¼	2749 ÅU	2495 ÅU
½	2749 „	2327 „
1	2749 „	2327 „
2	2749 „	2067 „
3	2749 „	1996 „
4	2841 „	1895 „
5	2841 „	1895 „
6	2841 „	1895 „
8	2874 „	1887 „
10	2874 „	1887 „
20	2948 „	1869 „
40	2948 „	1859 „

TABLE 5.

Germ: Sarcina.
Culture-medium: Agar agar.
Source of light: Condensed spark of iron.

Time of exposure in minutes	Upper limit of wave length having bactericidal action	Lower limit of wave length having bactericidal action
¼	2749 ÅU	2632 ÅU
½	2749 „	2360 „
1	2749 „	2327 „
2	2749 „	2250 „
3	2749 „	2224 „
4	2749 „	2110 „
5	2749 „	2110 „
6	2841 „	2085 „
8	2841 „	2067 „
10	2841 „	2000 „
20	2841 „	1944 „
40	2784 „	1895 „

TABLE 6.

Germ: Micrococcus pyogenes.
Culture-medium: Agar agar.
Source of light: Condensed spark of iron.

Time of exposure in minutes	Upper limit of wave length having bactericidal action	Lower limit of wave length having bactericidal action
1	2749 ÅU	2632 ÅU
2	2749 „	2551 „
4	2749 „	2348 „
6	2749 „	2348 „
8	2749 „	2327 „
10	2749 „	2327 „
15	2841 „	2250 „
20	2841 „	2250 „
40	2948 „	2085 „
80	2948 „	2067 „

TABLE 7.

Germ: Vibrio (Intestine Vibrio).
Culture-medium: Agar agar.
Source of light: Condensed spark of iron.

Time of exposure in minutes	Upper limit of wave length having bactericidal action	Lower limit of wave length having bactericidal action
$\frac{1}{4}$		
$\frac{1}{2}$	2749 ÅU	2418 ÅU
1	2749 „	2360 „
2	2749 „	2327 „
3	2749 „	2224 „
4	2749 „	2110 „
5	2749 „	2067 „
6	2841 „	2067 „
7	2841 „	2000 „
10	2841 „	2000 „
20	2874 „	1913 „
40	2948 „	1895 „

TABLE 8.

Germ: Water-Vibrio (Takasu Vibrio).
Culture-medium: Agar agar.
Source of light: Condensed spark of iron.

Time of exposure in minutes	Upper limit of wave length having bactericidal action	Lower limit of wave length having bactericidal action
1	2749 ÅU	2327 ÅU
2	2841 „	2085 „
3	2841 „	2000 „
4	2841 „	2000 „
5	2841 „	2000 „
6	2841 „	1944 „
8	2841 „	1895 „
10	2874 „	1895 „
20	2874 „	1887 „
40	2948 „	1877 „

TABLE 9.

Germ: Water-Vibrio (Kôbe Vibrio)
Culture-medium: Agar agar.
Source of light: Condensed spark of iron.

Time of exposure in minutes	Upper limit of wave length having bactericidal action	Lower limit of wave length having bactericidal action
$\frac{1}{4}$	2749 ÅU	2551 ÅU
$\frac{1}{2}$	2749 „	2445 „
1	2749 „	2360 „
2	2749 „	2348 „
3	2749 „	2327 „
4	2749 „	2327 „
5	2784 „	2110 „
6	2784 „	2110 „
8	2841 „	2067 „
10	2874 „	1913 „
20	2874 „	1877 „

B. The determination of the limits of wave lengths of light having the bactericidal action. (Long exposure)

TABLE 10.

Germ: Bacillus coli communis.
Culture-medium: Agar agar.
Source of light: Condensed spark of iron and cadmium.

Time of exposure in minutes	Upper limit of wave length having bactericidal action	Lower limit of wave length having bactericidal action
150	2948 ÅU	1856 ÅU

TABLE 11.

Germ: Bacillus coli communis.
Culture-medium: Agar agar.
Source of light: Condensed spark of iron and cadmium.

Time of exposure in minutes	Upper limit of wave length having bactericidal action	Lower limit of wave length having bactericidal action
300	2986 ÅU	1856 ÅU

C. The effect of rays upon media sensitized by methylene blue.

TABLE 12.

Germ: Bacillus subtilis.
Culture-medium: Agar agar containing methylene blue (0·01%).
Source of light: Condensed spark of iron.

Time of exposure in minutes	Upper limit of wave length having bactericidal action	Lower limit of wave length having bactericidal action
1	2632 ÅU	2551 ÅU
2	2749 „	2360 „
4	2749 „	2348 „
6	2749 „	2327 „
8	2749 „	2327 „
10	2749 „	2250 „
15	2749 „	2250 „
20	2841 „	2144 „
40	2841 „	2085 „
80	2948 „	1895 „

TABLE 13.

Germ: Bacillus coli communis. Before smearing methylene blue (0·01%) added to bacteria-suspension.
Culture-medium: Agar agar.
Source of light: Condensed spark of iron.

Time of exposure in minutes	Upper limit of wave length having bactericidal action	Lower limit of wave length having bactericidal action
80	2841 ÅU	2250 ÅU

From the data given above, it may be seen that the bactericidal effect of the light begins suddenly at about $\lambda 295\,\mu\mu$, reaches the maximum at about $275\,\mu\mu$, and then decreases slowly. The lower limit of the bactericidal action at the extreme ultraviolet is about $186\,\mu\mu$, this number agreeing well with that given by Strebel[1]. It is important to notice that this effect of the rays is independent of the nature of the bacteria and the culture-media employed.

The bactericidal power of methylene blue under the exposure of light was next studied, but the effect could not be decidedly observed, so far as the present experiment is concerned. This is not in harmony with that of Keller[2].

From the results mentioned above, it may be considered that the most part of the sunlight which has a bactericidal action lies in the ultraviolet region beyond $\lambda 295\,\mu\mu$. To confirm this, the writer prepared three inoculated culture-media, the first was covered by a glass plate of ten mm. thickness to cut off the rays beyond $295\,\mu\mu$, the second by a glass plate of one mm. in thickness which is sufficient to prevent drying but transmits the rays, while the third was kept uncovered. Each of these culture-media were exposed to the sunlight for thirty minutes in August. After the incubation it was found that the bacteria in the second and third media were sterilized, but not in the first.

Discussion.

Cernovodeanu and Henri[3] observed that the microscopic figures of bacteria sterilized by ultraviolet rays were the same as those killed by heat-coagulation, and consequently they considered that the bactericidal action of ultraviolet rays was to cause the coagulation of the protoplasm of bacteria. They also considered that the hydrogen peroxide produced in the culture-medium by exposing it to the ultraviolet rays was not

1 Loc. cit.

2 A. Keller, Centralbl. f. Bakteriol., Ref., **40**, 186 (1907).

3 P. Cernovodeanu & V. Henri, C. R., **150**, 52 & 549 (1910).

the cause of the bactericidal action. Besides this, there are many other opinions[1] on this subject, but they are not concordant.

In our case the image of the spectral lines impressed on the inoculated culture-medium seems to be caused perhaps by the sterilization of bacteria by the light rays, but not by its inhibitory action on their growth, for even with the very long incubation of 48 hours or more the transparency of the image of the spectral lines is not altered.

The ultraviolet rays which sterilize the bacteria seem not to produce any toxical substances for bacteria in the culture-medium, because in that part where the image of the spectral lines was impressed, newly inoculated germs grew just as well as on an untreated medium.

Now, ultraviolet rays behave inhibitorily toward fermentations, which are most important factors in the metabolism of organism. In order to see whether this action of the rays has a certain relation to their bactericidal effect, the writer examined the action of the rays on ferments by the method described above.

The starch (Kuzu in Japan) paste, coagulated by steam was used as a culture-medium, and a small quantity of Taka-diastase was smeared on its surface. This preparation was put in a special plate holder of brass having water cooling. Even with four hours exposure to the light, no trace of the effect could be detected.

Again, egg-albumin coagulated by steam, was smeared with a small quantity of pancreatin, or pepsin containing dilute hydrochloric acid of 0.2 per cent. With four hours exposure, the result was found to be also negative.

Lastly, catalase in the juice of leaves of clover (Triforium repens, L) and oxydase in apple and in egg-plant (Solanum melongena, L) were exposed to the light of a quartz mercury lamp, but the result was also negative, even after thirty minutes exposure.

Considering these facts, we see that the inhibitory action of the ultraviolet rays on fermentation has no relation to their bactericidal action.

As to the nature of the bactericidal action of the ultraviolet rays, no definite conclusion could be drawn. It seems, however, to me that

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1 V, Henri & his wife C. R. **159**, 413 (1914).
Cf. P. Achalme, Électronique et biologie, p, 334 (1913).
W. E. Burge, Amer. J. Physiol., **43**, 429 (1917).

the bactericidal curves obtained above may be useful for further study in the mechanism of this phenomenon.

In the present investigation, non-pathogenic germs were used, and a further investigation on pathogenic germs will be carried out in the near future.

The writer's cordial thanks are due to Profs. T. Mizuno and M. Kimura and to Assistant Prof. U. Yoshida for their kind suggestions and advice, and also to Assistant Prof. T. Toyoshima for his kind supply of the purely isolated germs of bacteria.

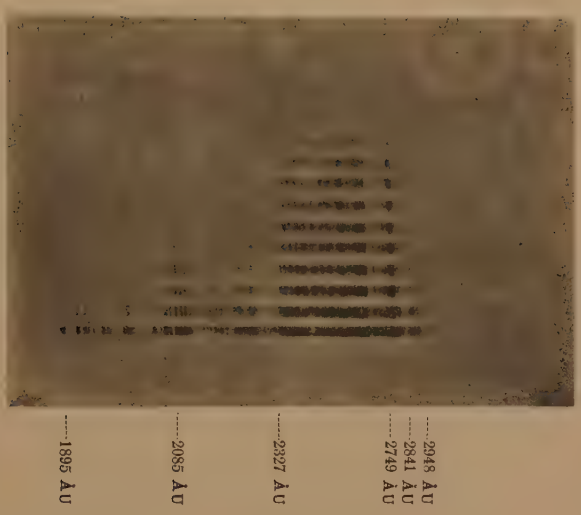

1895 ÅU
2085 ÅU
2327 ÅU
2749 ÅU
2841 ÅU
2948 ÅU

Fig. 1.

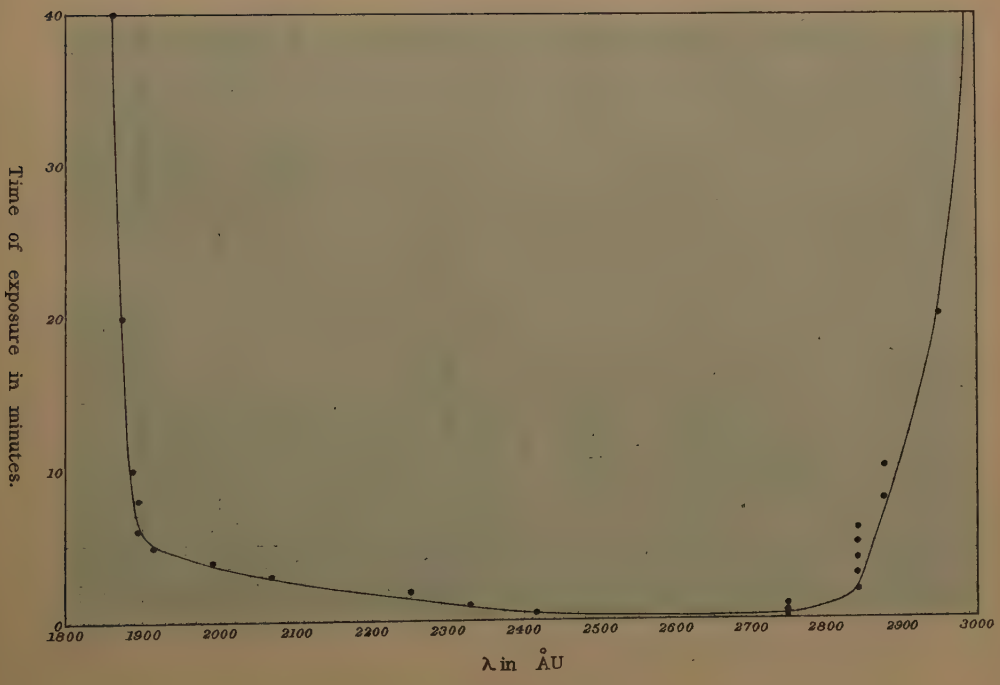

Time of exposure in minutes.
40
30
20
10
0
1800
1900
2000
2100
2200
2300
2400
2500
2600
2700
2800
2900
3000
λ in ÅU

Fig. 2.

Light-curves of several recent Novae, and some notes on the general features thereof.

By

I. Yamamoto.

(Received March 24, 1919)

(I) Provisional light-curve of Nova Aquilae.

Since my undergraduate course, some seven years ago, the New Star problem has been one of my subjects of study. Beginning with Nova Geminorum No. 2, of 1912, for convenience, many light-curves of comparatively recent objects were obtained, the physical interpretations of which, in terms of spectroscopic data, being mainly attacked. Some results were read several times in public meetings, the following being some of the remarks among others:

1. "Studies on New Stars, with special references to Nova Geminorum No. 2," on Oct. 30., 1913, at Meeting Phys. Inst.

2. "On Nova Lacertae," on Feb. 21., 1914, at Meeting, Phys. Inst.

3. "Spectral transformations of Novae," on Nov. 25., 1916, at Meeting Phys. Inst.

4. "On New Stars," on Feb. 21., 1918, at Meeting Phys. Inst.

Most recently a remarkable member has been found in Nova Aquila No. 3, and the careful study of its nature has become one of my daily labours since then. A preliminary light-curve being my first necessity, I obtained one last December, which is here reproduced. As it is now too early for us to get observational data from foreign countries, however, I was obliged to content myself with those of my own country-men only. Provisionally I found five observers here, among whom Mr. Sekiguti has already published his own estimations of magnitudes in the "Temmon-Geppo," and Messrs. Ueta and Kudara have respectively

added their valuable observations to my own, while Mr. Sasaki sent me in letters his elaborate data. To these gentlemen my sincere thanks are due for this work.

Being quite preliminary in nature, and also of provisional necessity, the curve was drawn by inspection through the most probable mean values of individual observations, plotted on paper. Although this was been smoothed out partially with too scanty materials, the general form can be rather well traced, which is sufficient for my hasty examinations. Let me give here a statistical table of the materials used :

Observers	Estimations	Mean. Magnitudes	Nights
Mr. K. Sekiguti	102	29	23
Mr. Y. Ueta	42	36	35
Mr. Kudara	250	103	94
Mr. T. Sasaki	53	32	28
Mr. K. Yamamoto	80	38	38

(II) Light-curves of 5 recent New Stars.

In this connection I here reproduce more or less definite light-curves of five Novae of comparatively recent discovery, all of which were obtained from as many available materials as possible.

My method of obtaining the light-curve is this : I prefer generally *continuous* observations to any isolated data, especially are those made during several consecutive days welcomed as most valuable. Data of this kind are collected as many as possible, and plotted frankly on a sheet of section paper, taking Greenwich Mean Time as abscissa and the observed stellar magnitude as ordinate. Then those observations, which were observed by the same observer, and probably by the same means, are connected in the successive pairs by straight lines—here the connections between two consecutive days (or shorter intervals) must be valued most highly, so that the longer intervals are usually conected by dotted lines, by which the former kinds should be distinguished. After all connections have been made, a mean curve is drawn following the observations, and utmost care is taken to get the curve, each part of which should be as *parallel* to straight-line connections as possible.

By this method the absolute magnitudes may not be freely followed at the cost of time variations which are the most important to me. The general accuracy in magnitude is accordingly lowered, which is in these cases an unavoidable sacrifice for my purpose. Indeed, gradually it has become very clear to me that very rapid and complex fluctuations of light-intensities reasonably exist in New Stars, and sometimes the spectroscopic evidences are connected with them. This consideration has made me take the above method. And also, the art of smooth curve to express the "light-curve" has been changed into that of straight-line connection (as seen in these diagrams) by which to avoid the preoccupied images induced by the artificial smoothness of the drawn figure, and to allow any one freely to imagine the most probabale form of curve by means of apparently unnatural point-connection. (The light-curve of Nova Aquila is here exceptionally smoothed out.)

The light-curves of the Novae are here given in the order of establishment:

1) Nova Geminorum No. 2, 1912.

All materials were obtained at the library of the Kyoto University, amounting to 774 observations, and read on Oct. 30., 1913.

Mean Magnitudes.

G. M. T.	Mag.	G. M. T.	Mag.	G. M. T.	Mag.
d	*M*	*d*	*M*	*d*	*M*
1912 Mar. 11.8	5.0	Mar. 22.3	5.0	Apr. 4.3	6.1
12.3	4.35	23.3	4.9	5.3	6 1
13.4	4.2	24.0	4.7	6.4	6.55
13.6	4.1	24.4	4.65	7.3	6.5
14.3	3.9	25.3	5 05	8.4	6.3
14.5	3.7	26.4	5.9	9.4	6.1
15 3	4.2	27.3	6.6	10.4	6.5
15.4	4.4	28.4	6.2	14.4	6.5
16.4	5.5	29.3	6.2	12 4	6.3
17.3	5.45	30.4	5.6	13 4	6.6
18.4	5.4	31.3	6.1	14.4	6.6
19.3	5.4	Apr. 1.4	6.36	15.3	6.7
20.3	5.6	2.4	6 0	16.4	6.6
21.3	5.7	3.4	5.85	17.3	6.8

G. M. T.	Mag.	G. M. T.	Mag.	G. M. T.	Mag.
d	*M*	*d*	*M*	*d*	*M*
1912 Apr. 18.4	6.7	Apr. 29.4	7.1	May 13.3	7.7
19.4	6.55	30.4	7.0	14.4	7.8
20.4	6.8	Mar. 1.4	6.9	18.4	7.6
21.3	6.9	2.3	7.1	19.4	7.4
22.4	7.0	3.4	7.25	20.4	7.6
32.4	7.05	4.3	7.4	23.6	7.7
24.4	7.1	5.4	7.35	25.0	7.5
25.4	7.15	6.3	7.4	26.0	7.5
26.4	7.2	8.3	7.4	30.4	7.6
27.4	7.4	10.4	7.7		
28.5	7.5	12.4	7.5		

(2) Nova Lacertae, 1910–1911.

All materials were obtained at the library of the Kyoto University, amounting to 236 observations, and a paper on this curve was read on Feb. 21., 1914, at a regular meeting of the Physical Institute.

Mean Magnitudes.

(i) First series.

G. M. T.	Mag.	G. M. T.	Mag.	G. M. T.	Mag.
d	*M*	*d*	*M*	*d*	*M*
1910 Dec. 30.7	7.3	Jan. 20.25	8.5	Feb. 14.2	9.1
1911 Jan. 1.3	7.7	21.3	8.5	15.2	9.25
2.6	7.4	23.3	8.6	16.3	9.1
3.7	6.9	24.4	8.5	17.4	9.4
4.7	7.55	25.3	8.54	18.3	9.4
5.6	7.55	26.2	8.62	20.3	9.3
6.3	7.6	27.3	8 57	21.2	9.4
7.4	7.6	28.2	8.58	22.3	9 5
8.6	7.6	29.5	8.8	24.2	9.27
9.5	7.8	30.3	8.7	25.7	9.27
10.2	7.9	31.3	8.95	26.3	9.4
11.2	8.0	Feb. 1.3	8.8	27.3	9.1
12.6	8.15	2.3	8.8	28.4	9.0
13 6	8.2	3.4	8.8	Mar. 1.4	9.2
14.2	8.15	4.3	8.8	2.3	9.2
15.3	8.2	5.3	8.89	5.4	9.35
16.2	8.45	6.3	8.9	6.2	9.24
17.3	8.55	8.4	9.05	7.3	9.28
17.8	8.6	9.3	9.2	9.3	9.26
18.3	8.5	10.3	9.16	11.3	9.25
19.3	8.47	13.2	9.2		

As the original materials of the above values are very scant in number, the determinations of magnitudes after March 12th. are practically impossible with published data, which show somewhat traceable continuations to the end of the year. These have been combined to get the usual mean magnitudes, and given below as another series, together with the results treated similarly for the preceding period.

(ii) Second series.

G. M. T.	Mag.	G.M.T.	Mag.	G.M.T.	Mag.
d	*M*	*d*	*M*	*d*	*M*
1911 Jan. 2.5	7.4	Feb. 27.5	9.1	June 9.0	10.40
6.5	7.7	Mar. 4.5	9.2	24.0	10.45
10.5	7.7	14.5	9 3	July 4.0	10.68
13.0	8.0	19.5	9.3	13.0	10.50
20.0	8.4	27.0	9.3	Aug. 3.0	10.90
22.0	8.4	Apr. 2.0	9.5	23.0	10.50
25.5	8.6	9.0	9.6	Sept. 7.0	10.74
30.0	8.7	17.0	9 8	Oct. 2.0	10.90
Feb. 2.0	8.9	24.0	9.9	Nov. 1.0	11.45
9.0	9.15	May 2.0	9.5	21.0	11.26
17.5	9.05	17.0	10.26	Dec. 16.0	11.10

3) Nova Persei No. 2, 1901.

All of the materials, in this case, were collected at the library of the Mizusawa International Latitude Observatory, to whose Director my hearty thanks are due. A paper on this was read at a regular meeting of our Institute on November 25th., 1916.

Mean Magnitudes.

G. M. T.	Mag.	G. M. T.	Mag.	G. M. T.	Mag.
d	*M*	*d*	*M*	*d*	*M*
1901 Feb. 21.6	2.7	Feb. 24.6	0.5	Feb. 27.6	1.8
22.2	0.8	25.3	0.9	28.3	17.5
22.5	0.4	25.7	1.1	28.6	1.7
23.3	0.2	26.3	1.3	Mar. 1.3	1.9
23.6	0.2	26.6	1.4	1.7	2.2
24.4	0.5	27.4	1.7	2.3	2.5

G. M. T.	Mag.	G. M. T.	Mag.	G. M. T.	Ma
d	*M*	*d*	*M*	*d*	*M*
Mar. 2.6	2.3	Mar. 33.3	3.9	Apr. 24.3	5.5
3.3	2.5	24.3	4.2	25.3	5.9
4.4	2.5	24.6	5.2	26 4	5.8
5.3	2.4	25.3	5.4	27.4	4.4
6.3	2.9	26.3	43.5	28.4	5.35
6.7	3.0	26.6	3.9	29.4	6.0
7.3	2.9	27.3	3.8	30.4	6.0
7.6	2.8	28.3	4.8	May 1.3	5.8
8.4	3.3	29.3	4.8	2.3	4.6
9.4	3.6	30.3	4.25	3 4	5.6
10.4	3.4	31.4	4.5	4.4	5.9
11.3	3.3	Apr. 1.3	4.4	5.4	5.9
12.3	3.3	2.4	5.4	6.4	6.0
12.6	3.3	3.4	5.5	7.4	4.7
13.3	3.7	4.3	4.3	8.4	4.6
14.3	3.6	5.3	4.5	9.3	5.9
14.6	3.5	6.4	5.6	10.4	5 9
15.3	3.5	7.4	5.7	11.4	6.0
16.3	4.0	8.3	4.4	12.4	5.5
16.6	4.0	9.3	4 5	13.3	4.6
17.3	3 8	10.4	5.6	14.4	5.7
17.6	3.8	11.4	5.7	15.4	6.3
18.3	3.5	12.3	4.9	16.4	6.3
18.6	3 8	13.4	4.5	18.4	5.0
19.3	5.0	14.3	5.7	19.4	6.2
19.4	5.1	15 3	5.6	20.3	6.0
19.6	5.0	16.4	5 7	21.4	6.2
20.2	5.9	17.4	5.2	22.3	5.0
20.3	3.5	18 4	4.3	23.3	5.9
21.3	3.8	19.4	5.5	24.4	6.2
21.6	4.4	20.3	5.8	25.4	6.3
22.3	5.2	21.3	6.0	26.4	5.4
22.4	5.3	22 3	5.7		
22.6	5.0	23.3	4.3		

4) Nova Aurigae, 1892.

All the materials were collected at the library of the Kyoto University, and a paper in connection therewith was read on February 21st, 1918.

Mean Magnitudes.

G. M. T.	Mag.	G. M. T.	Mag.	G. M. T.	Mag.
d	*M*	*d*	*M*	*d*	*M*
1892 Feb. 1.3	5.3	Feb. 23.5	5.85	Mar. 18.4	9.05
2.3	5.3	24.3	5.95	19.4	9.2
3.4	4.8	24.7	5.75	20.6	9.55
4.3	4.95	25.7	5.5	21.7	9.65
5.4	4.6	26.6	5.6	22.7	9.8
6.3	4.5	26.75	5.45	23.6	10.1
7.4	4.45	27.7	5.3	24.4	10.2
8.7	4.4	28.7	5.2	25.5	11.25
9.7	5.1	29.8	5.35	27.3	11.55
10.6	5.12	Mar. 2.7	5.4	28.4	11.9
11.3	5.15	3 7	5.6	29.3	12.0
11.7	4.8	4.6	6.0	30.4	13.0
12.7	5.05	5.6	5.9	31.4	13.3
13.5	5.2	6.6	6.2	Apr. 1.4	13.4
13.8	5.08	7.7	6.1	2.4	13.5
14.7	4.8	8.6	6.2	3.4	13.5
15.6	5.95	9.55	6.8	4.7	12.5
16.5	5.97	10.7	7.5	7.7	14.4
17.5	5.35	11.6	7.8	12.7	14.95
17.7	5.0	12 4	7.55	15.6	15.2
18.5	5 0	13.5	7.8	18.6	15.55
20.65	5.05	14.6	8.0	22.7	16.55
21.9	5.35	15.6	8.5	24.7	16.8
22.6	5.80	16.6	8.6	26.7	17.4
22.75	5.7	17.3	8.8		

It is to be regretted that in the latter part of this curve the observations are not rich so that the values above given are not fully relied upon: figures of the first decimals are uncertain.

5) Nova Geminorum No. 1, 1903.

Observational data were collected at the Kyoto University, and a paper on it was read on February 21st, 1918, in the same occasion as the preceding.

Mean Magnitudes.

G. M. T.	Mag.	G. M. T.	Mag.	G. M. T.	Mag.
d	*M*	*d*		*d*	*M*
1903 Mar. 6.6	5.1	Apr. 12.6	8.5	May 3.4	9.1
11.6	6.7	13.4	8 8	4.5	9 2
12.6	7.1	14 4	8.8	5.4	9 1
13 5	7.2	15.4	8.7	6 4	9 3
14.6	7.4	16.4	8 6	7.3	9.4
15.3	7.2	17.5	8.7	8.5	9.6
15.7	7.5	18.6	8 8	9 3	9 75
16 6	7.5	19.4	9.1	11.5	9.65
25 6	8.0	20.3	9.0	12.4	9.3
27.4	8.1	21.6	8.8	13.4	9.4
28 4	8.3	24 4	9 4	14.4	9.2
29.4	8.2	25 4	9 6	15.4	9.3
30.3	8.3	26.4	9 6	18.4	9.35
31.4	8.3	27.4	9 6	19.4	9.3
Apr. 1 6	8.4	28 4	9.5	20.4	9.2
3.4	8.6	29.4	9.3	21.4	9.4
4.6	8.7	30.4	9.5	22.4	9.5
10.6	8.8	May 1.6	9.45	23.4	9.5
11.6	8.8	2.3	9.15	24.4	9.5

(III) Notes on general features.

Let here be given briefly a summary of, and the present ideas about, the New Star Phenomena. Common features, which are clearly seen in the above mentioned stars and probably in all the rest of this kind are

1) Rapid decreasing of light intensity after the maximum phase;

2) More or less periodic fluctuations of light intensity during the decreasing stage;

3). Some regular spectroscopic transformations, i. e., in the order of B-type to F-type, Nova peculiar, Nebular, Planetary Nebular, and Wolf-Rayet type;

4) Peculiarities in the spectra, especially the curious juxtapositions of bright and dark lines of the same chemical origin, always in the same scheme, i. e., the bright components at the less refrangible side and the dark ones at the other side;

5) Great width in the spectral lines;

6) Prevailing behaviour of Hydrogen, Helium, and Calcium, as well as of the unknown Nebulium;

7) Large relative radial velocities shown in the Doppler interpretations of the juxtaposed components of the spectral lines;

8) Connections with suspected surrounding nebulosities. Of the above, the following physical meanings may be suggested: 1) shows that the material masses closely concerned in the phenomenon are very small, even compared with the tiniest members ever known in the solar system, or otherwise the cooling would take longer; this idea of small mass can also be applied to the explanation of 2); 6) makes us easily recall the similar facts in the solar prominences, close studies on which also throw some light on 7), and lead us a step farther that the whole phenomena may be imagined as extreme cases of solar prominences, of course eruptive in nature; from this idea and moreover from the probable fact that the spectral displacements of the dark components of 4) are possibly proportional to wave-lengths while it is not so in the bright ones, the most difficult problem of 4) can be solved if we suppose a tremendous gas-outburst on the stellar surface, in which the displacements of tho bright lines are due to the eccentric absorption by the dark components arising from high velocity eruptions of gases (amounting to about 1000 to 2000 killometers or over, which velocities can almost be paralleled by those of prominences), whose relatively low temperatures can be allowed by the consideration of their high altitudes reached above the surface. 5) shows very complex and extreme states of the gaseous field, and at the same time 3) and 8) suggest to us some conditions transcendental, to an extent, to our terrestrial experiences. These ideas were read at the last two meetings at Kyoto already mentioned. Recently, a paper by Mr. W. H. Pickering on quite similar problems was received by our library in Pop. Ast. Nov., 1918, in which a theory of planetesimal encounter was successfully treated, reaching almost to the similar gaseous behaviours as the above

mentioned ones but not apparently to a prominence. His paper, however, was very suggestive to me naturally, and immediately led me to the idea of connecting the New Star, the Meteoric actions, and indeed the interesting theory of Sun-Spots proposed some time ago by Prof. H. H. Turner (Monthly Notices R. A. S. Vol. 74, p. 82.)

The detailed studies of the problem will follow in another paper later.

Kyoto University Observatory,

January 24th., 1919.

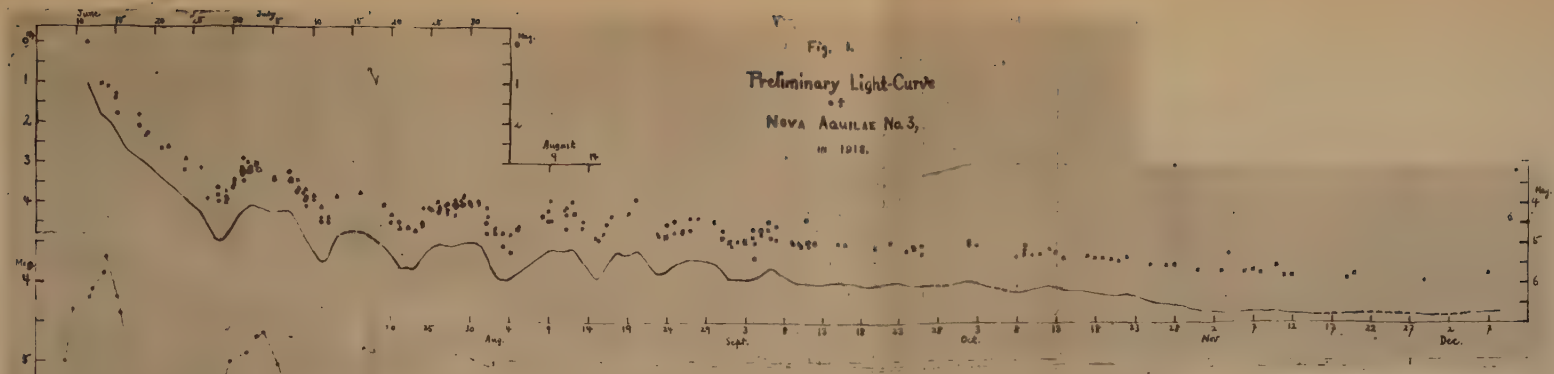


Fig. 1.
Preliminary Light-Curve
of
Nova Aquilae No. 3,
in 1918.

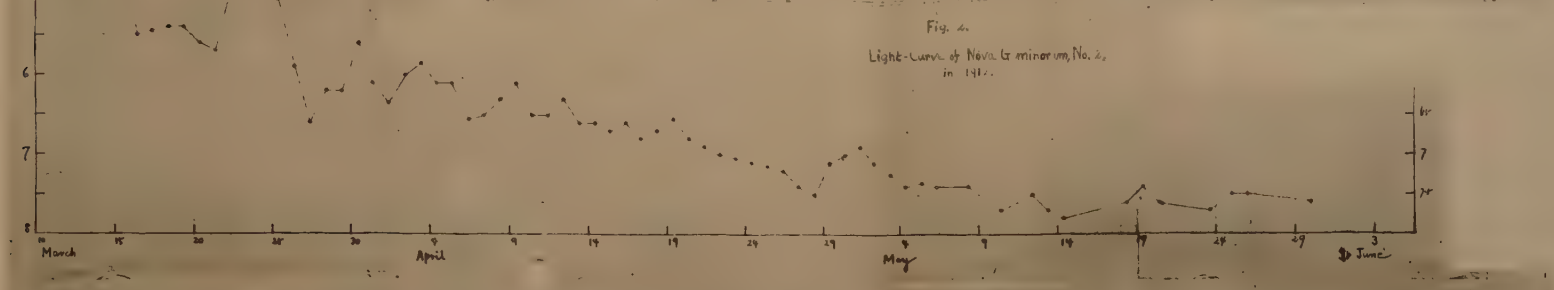


Fig. 2.
Light-Curve of Nova G minorum, No. 2,
in 1901.

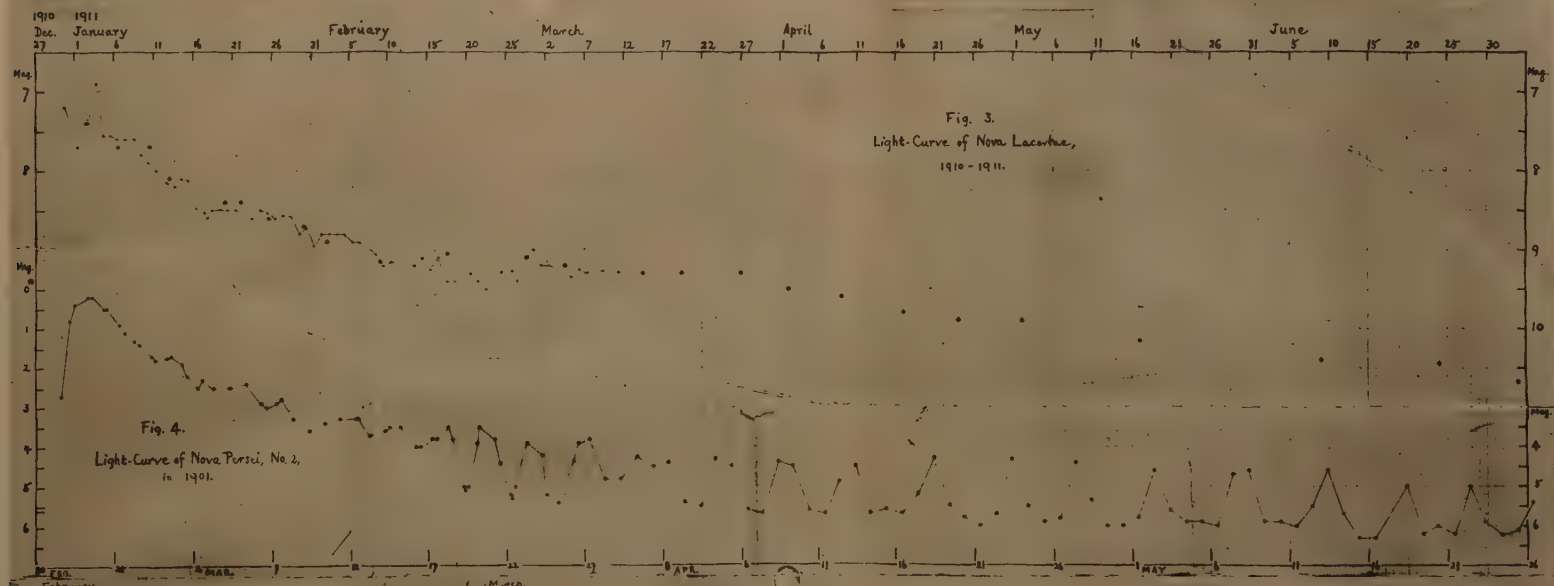


Fig. 3.
Light-Curve of Nova Lacertae,
1910 - 1911.

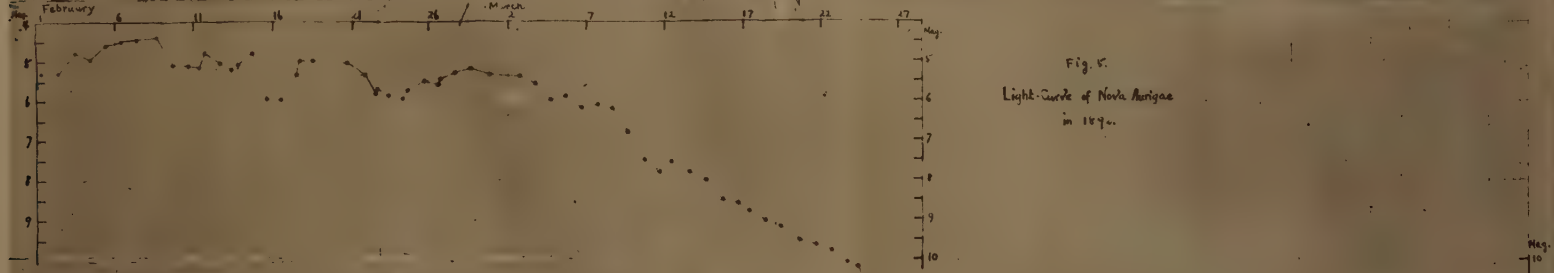


Fig. 4.
Light-Curve of Nova Persei, No. 2,
in 1901.

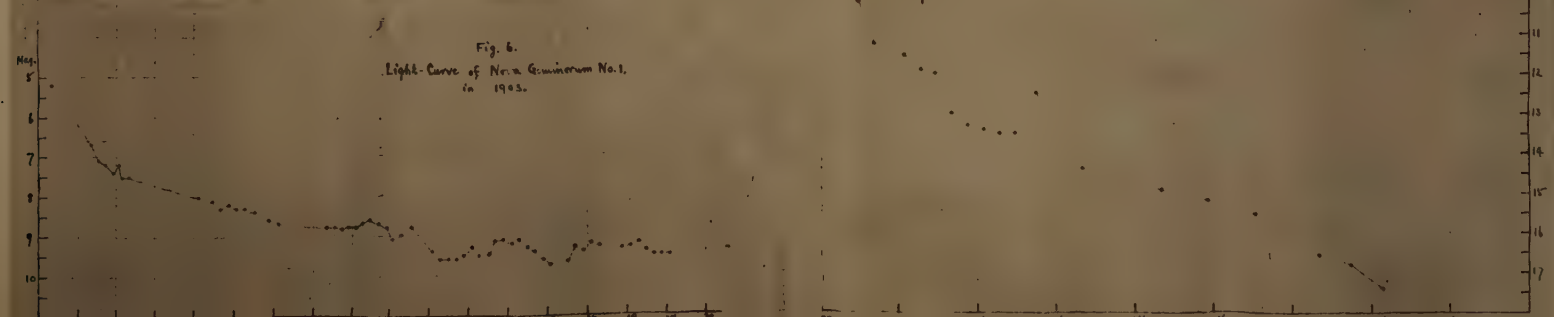


Fig. 5.
Light-Curve of Nova Aurigae
in 1891.

Fig. 6.
Light-Curve of Nova G. minorum No. 1.
in 1903.

Observations of Nova Aquilae No. 3.

By

I. Yamamoto, Y. Ueta, and **K. Kudara.**

(Received May 21, 1919)

Introduction.

The Nova Aquilae, No. 3, was found by the first two of the writers on the occasion of the Solar Eclipse Expedition at Torisima (St. Peter's Island) in the Northwest Pacific Ocean, at about 2^h Greenw. Mean Time on June 11, 1918. At that time, however, no suitable instrumental equipment being available only magnitude estimations, visually, were made, and that thru broken cloud. They returned to Kyoto a few days later, arriving there on June 16, when they learnt that Mr. Kudara had also noticed the Nova and begun observations. Since then, a constant watch has been kept by us three. To our deepest regret, the rainy season had already begun, so that we were very often troubled by meteorological irregularities.

(i) Estimations of Magnitudes.

Magnitudes were estimated usually by the method of interpolation, comparisons being made with neighbouring stars, and the Harvard system of scale adopted. Most of the reductions were made by Kudara.

1) I. Yamamoto's Estimations.

Observations were made at Kyoto with the naked eye, unless otherwise stated, during the first half of the series; but, for the remaining period, more precisely, after August 3, the Observer made an excursion to the Kasumi-ga-ura Region, east of Tokyo for Gravity Measurements, during which the observations were made with a pair of binoculars, the names of daily stations will be found in the column of Remarks.

Date Gr. M. T.	Estimation	Magnitude	Remarks
	h M	M	
1918 June 11, 1.8	0.1>Vega	0.0	at Torisima
15, 2.0	(roughly compared w. Altair)	1.8	in Tokaido Line
18, 2.0	N=α Ophiuchi	2.14	
19, 2.0	(rough estimation)	2.3	
28, 1.5	N=72 Ophiuchi	3.73	
	N a little <λ Aquilae	3.60	
	η Serpentis 5 N 5 72 Ophiuchi	3.58	
29, 1.2	η Serpentis 5 N 5 θ Serpentis	3.76	
30, 0.5	N=η Serpentis	3.42	
July 1, 0.0	0.2>η Serpentis	3.22	
3.0	N=λ Aquilae	3.55	
	N=η Serpentis	3.42	
5.0	ζ Aquilae 5 N 5 η Serpentis	3.22	
2, 0.0	N=ζ Aquilae	3.02	
0.3	β Ophiuchi 2 N 1 η Serpentis	3.26	
0.5	ζ Aquilae 5 N 5 η Serpentis	3.22	
3, 0.0	0.2<ζ Aquilae	3.20	(?)
7, 0.0	ζ Aquilae 5 N 5 η Serpentis	3.22	
2.0	=η Serpentis	3.42	
8, 0.0	η Serpentis 1 N 2 θ Serpentis	3.65	
	=δ Aquilae	3.44	
0.5	λ Aquilae 2 N 2 θ Serpentis	3.83	
9, 0.5	η Serpentis 4 N 6 θ Serpentis	3.69	
	λ Aquilae 5 N 5 θ Serpentis	3.83	
	δ Aquilae 5 N 5 θ Serpentis	3.77	
12, 1.0	=θ Serpentis	4.10	
26, 0.0	λ Aquilae 7 N 3 θ Serpentis	3.94	
	η Serpentis 2 N 1 θ Serpentis	3.87	
29, 0.5	λ Aquilae 2 N 1 θ Serpentis	3.92	
	δ Aquilae 1 N 1 θ Serpentis	3.77	
30, 1.0	λ Aquilae 1 N 1 θ Serpentis	3.83	
31, 1.0	η Serpentis 5 N 5 θ Serpentis	3.76	
Aug. 1, 1.0	=θ Serpentis	4.10	
2, 0.0	fainter! (rapid)		
5, 0.5	θ Serpentis 1 N 2 4 Aquilae	4.41	Kumagaya
	N 1 4 Aquilae 2 *e* Serpentis	4.66	Kumagaya
8, 0.5	=θ Serpentis	4.10	Oomiya
	η Serpentis 2 N 1 θ Serpentis	3.87	Oomiya
9, 2.0	δ Aquilae 5 N 5 θ Serpentis	3.77	Tatebayasi
	η Serpentis 6 N 4 θ Serpentis	3.83	Tatebayasi
11, 0.7	0.2>θ Serpentis	3.90	Tomonuma
	η Serpentis 4 N 1 θ Serpentis	3.96	Tomonuma
	δ Aquilae 3 N 1 θ Serpentis	3.93	Tomonuma
	12 Aquilae 2 N 2 θ Serpentis	4.13	Tomonuma
	N 1 θ Serpentis 3 4 Aquilae	3.79	Tomonuma
23.3	N 2 θ Serpentis 2 4 Aquilae	3.17	Hiratuka
	δ Aquilae 2 N 2 θ Serpentis	3.77	Hiratuka
	η Serpentis 3 N 2 θ Serpentis	3.83	Hiratuka
	λ Aquilae 2 N 2 12 Aquilae	3.85	Hiratuka

		h		M	
Aug.	13,	3.5	θ Serpentis 1 N 3 4 Aquilae	4.34	Kugeta
			N 1 4 Aquilae 2 *e* Serpentis	4 66	
			λ Aquilae 3 N 1 12 Aquilae	4.00	
	15,	2.8	4 Aquilae 2 N 7 *e* Serpentis	5.21	Isige
			θ Serpentis 4 4 Aquilae 2 N	5.51	
			12 Aquilae 4 N 2 4 Aquilae	4.74	
			=β Scuti	4.47	
	16,	2.5	θ Serpentis 5 N 1 4 Aquilae	4.88	Yosinuma
			=12 Aquilae	4.15	
	20,	0.5	δ Aquilae 1 N 3 θ Serpentis	3.61	Suganoya
			=12 Aquilae	4.15	
	23,	23.7	θ Serpentis 1 N 2 4 Aquilae	4.41	Hadori
			12 Aquilae 1 N 2 4 Aquilae	4.45	
	24,	22.5	θ Serpentis 1 N 2 4 Aquilae	4.41	Ami
			=12 Aquilae	4.15	
			=β Scuti	4.47	
	31,	0.0	θ Serpentis 2 N 3 4 Aquilae	4.48	Motosu
			12 Aquilae 2 N 2 4 Aquilae	4.60	
			β Scuti 2 N 2 4 Aquilae	4.76	
		23.0	=4 Aquilae	5.04	Katoozu
			θ Serpentis 2 N 1 4 Aquilae	4.73	
Sept.	2,	23.5	=4 Aquilae	5.04	Simohataki
			β Scuti 3 N 1 4 Áquilae	4.90	
	4,	0.5	θ Serpentis 4 4 Aquilae 1 N	5.28	Ikisu
			β Scuti 2 4 Aquilae 2 N	5.61	
		22.5	θ Serpentis 2 N 2 4 Aquilae	4.57	Karuno-Takahama
			=β Scuti	4.47	
			12 Aquilae 2 N 2 4 Aquilae	4.60	
	5,	22.0	θ Serpentis 2 N 3 4 Aquilae	4.48	Iside
			=12 Aquilae	4.15	
	10,	22.0	θ Serpentis 2 N 6 4 Aquilae	4.34	Tokusima
			=12 Aquilae	4.15	
			12 Aquilae 2 N 10 4 Aquilae	4.30	

2) Y. Ueta's Estimations.

All observations were made at Kyoto, unless otherwise remarked, with the naked eye.

Date	Gr. M. T.	Estimation	Magnitude	Remarks
	h		M	
1918 June	15, 2 0	(rough estimation)	1.3	at Tokyo
	28, 1.5	N>9 Serpentis	4.0	
	29, 1.2	η Serpentis 5 N 5 β Scuti	3.95	
	30, 0.0	N 3 θ Serpentis 4 64 Serpentis	2.94	
July	1, 3.0	ζ Aquilae 3 N 1 η Serpentis	3.32	
	7.0	N 1 δ Aquilae 2 θ Serpentis	3.11	
	2, 3.0	γ Aquilae 2 N 1 η Serpentis	3.21	
	3, 0.0	ζ Aquilae 1 N 1 γ Aquilae	2.91	
		γ Aquilae 3 N 2 η Serpentis	3.17	
	5, 1.0	N=η Serpentis	3 42	

		h		M
July	7,	2.0	η Serpentis 1 N 1 δ Aquilae	3.43
	9,	1.0	η Serpentis 5 N 5 θ Serpentis	3.76
	11,	0.1	N=θ Serpentis	4.10
	16,		N>θ Serpentis	<4.10
	21,		N=θ Serpentis	4.10
	27,		θ Serpentis 3 N 7 η Serpentis	3.90
	28,		θ Serpentis 3.5 N 6.5 η Serpentis	3.86
	29,		θ Serpentis 4 N 6 η Serpentis	3.83
			θ Serpentis 5 N 5 λ Aquilae	3.83
Aug.	1,		N 2 θ Serpentis 8 η Serpentis	4.27
	2,		N 2 θ Serpentis 8 η Serpentis	4.27
	3,		N 3.5 θ Serpentis 6.5 η Serpentis	4.47
	4,		N 4 θ Serpentis 6 η Serpentis	4.55
	8,	23.3	η Serpentis 4 N 6 4 Aquilae	4.07
			N 0.5 θ Serpentis 9.5 η Serpentis	4.14
			0.1^{M}<θ Serpentis	4.2
	11,	1.0	η Serpentis 9 θ Serpentis 1 N	4.18
	12,		η Serpentis 9.5 θ Serpentis 0.5 N	4.14
			4 Aquilae 8 N 2 λ Aquilae	3.85
	23,	23.0	η Serpentis 7 θ Serpentis 3 N	4.39
			θ Serpentis 8 N 2 4 Aquilae	4.85
	25,	23.0	η Serpentis 8 θ Serpentis 2 N	4.27
	26,	23.0	η Serpentis 9 θ Serpentis 1 N	4.18
			θ Serpentis 4 N 6 4 Aquilae	4.48
Sept.	4,	23.5	4 Aquilae 2 N 8 θ Serpentis	4.85
	6,	2.5	4 Aquilae 4 N 6 θ Serpentis	4.66
		23.0	4 Aquilae 3 N 7 θ Serpentis	4.76
	9,	0.5	θ Serpentis 9 N 1 4 Aquilae	4.95
	10,		a little>4 Aquilae	5.0
	11,	2.0	=4 Aquilae	5.04
	24,	22.5	=4 Aquilae	5.04
	25,	23.0	=4 Aquilae	5.04
Oct.	9,	0.0	=4 Aquilae	5.04

3) K. Kudara's Estimations.

Until the beginning of August, the observations were made with the naked eye, while on and after August 2, a pair of binoculars was used throughout. The site of the Observer was usually at Kyoto, but between July 28 and September 14 he was at Osaka; on three other occasions, which are specially remarked below, he was in Osaka.

Date	Gr. M. T.		Estimation	Magnitude	Remarks
		h		M	
1918 June	13,	5.3	Altair 1 N 9 α Ophiuchi	1.02	Bluish
	14,	2.9	Altair 1.4 N 8.6 α Ophiuchi	1.07	Yellowish
		3.2	Altair 6 N 4 α Cygni	1.15	
	19,	0.5	α Ophiuchi 5 N 5 η Ophiuchi	2.39	Reddish

		h		M	
June	21,	2.3	α Ophiuchi 6 N 4 ζ Aquilae	2.67	Moon
			N 6 β Ophiuchi 4 ζ Aquilae	2.82	
			α Ophiuchi 7.5 N 2.5 β Ophiuchi	2.74	
			N 5 γ Aqulae 5 ζ Aquilae	2.58	
			α Ophiuchi 7 N 3 β Ophiuchi	2.70	
	24,	0.5	≦β Cygni	3.10	Full Moon ; cloudy.
	28,	1.5	η Serpentis 7 N 2 θ Serpentis	3.95	
			λ Aquilae 5 N 4 θ Serpentis	3.86	
			N=δ Aquilae	3.44	
			N 4 θ Serpentis 6 4 Aquilae	3.47	
	29,	1.2	N 5 θ Serpentis 5 4 Aquilae	3.16	(?)
			η Serpentis 6 N 4 θ Serpentis	3.83	
	30,	0.0	=η Serpentis	3.42	
		0.5	η Serpentis 5 N 5 δ Aquilae	3.43	
			N 6 θ Serpentis 4 4 Aquilae	2.69	
			η Serpentis 3 N 7 θ Serpentis	3.62	
			N>α Scuti	<4.06	
			λ Aquilae>N	>3.55	
July	1,	3.0	α Ophiuchi 9 N 1 λ Aquilae	3.41	
			β Ophiuchi 6 N 4 72 Ophiuchi	3.41	
			N 3 θ Serpentis 7 4 Aquilae	3.70	
			β Ophiuchi 5.5 N 4.5 λ Aquilae	3.28	
		5.0	ζ Aquilae 4 N 6 δ Aquilae	3.19	
		23.0	β Ophiuchi 7 N 3 ζ Aquilae	3.00	
	2,	4.5	β Ophiuchi 4 N 6 δ Aquilae	3.14	
			ζ Aquilae 2 N 8 δ Aquilae	3.10	
			β Ophiuchi 4 N 6 η Serpentis	3.13	
		23.0	=ζ Aquilae	3.02	
	5,	1.0	ζ Aquilae 9 N 1 η Serpentis	3.38	
	7,	2.5	η Serpentis 3 N 7 δ Aquilae	3.43	
	8,	4.0	=η Serpentis	3.42	
	9,	1.0	η Serpentis 6 N 4 θ Serpentis	3.83	
			λ Aquilae 6 N 4 θ Serpentis	3.88	
	11,	0.3	η Serpentis 9 N 1 θ Serpentis	4.03	
	12,	0.5	η Serpentis 9 N 1 θ Serpentis	4.03	
	16,		>θ Serpentis	<4.10	
	19,	1.5	η Serpentis 8 N 2 θ Serpentis	3.96	
			λ Aquilae 8 N 2 α Scuti	3.96	
			N 2 θ Serpentis 8 4 Aquilae	3.86	Moon light
			λ Aquilae 5 N 5 β Scuti	4.01	
			λ Aquilae 6 N 4 θ Serpentis	3.88	
			η Serpentis 6 N 4 α Scuti	3.80	
	20,	0.0	N=θ Serpentis	4.10	Moon
	24,	0.0	θ Serpentis 2 N 8 4 Aquilae	4.29	Moon
			λ Aquilae 7 N 3 4 Aquilae	4.59	
			β Scuti 2 N 8 η Scuti	4.58	
	25,	23.5	η Serpentis 8 N 2 θ Serpentis	3.96	Before moon-rise
			η Serpentis 9 N 1 α Scuti	4.00	

		h		M	
July	25,	23.5	η Serpentis 4 N 6 β Scuti	3.84	
			λ Aquilae 5 N 5 12 Aquilae	3.85	
			λ Aquilae 6 72 Ophiuchi 4 N	3.85	
		23 8	N>α Scuti	<4.05	
	26,	4.7	N 2 θ Serpentis 8 4 Aquilae	3.86	Moon
			λ Aquilae 5 N 5 β Scuti	4.01	
	27,	1.6	η Serpentis 8 N 2 θ Serpentis	3.96	Moon
	28,	4.2	λ Aquilae 8 N 2 θ Serpentis	3.99	Moon
	31,	1.5	η Serpentis 8 N 2 θ Serpentis	3.96	
			λ Aquilae 4 N 6 12 Aquilae	3.79	
			67 Ophiuchi 5 N 5 70 Ophiuchi	4.00	
			λ Aquilae 4 N 6 η Scuti	4.15	
			λ Aquilae 5 N 5 12 Aquilae	3.85	
Aug.	1,	1.0	θ Serpentis 1 N 9 4 Aquilae	4.19	
			λ Aquilae 6 N 4 12 Aquilae	3.91	
		3.2	α Scuti 2 N 8 β Scuti	4.14	
			λ Aquilae 6 N 4 4 Aquilae	4.44	
			θ Serpentis 1 N 9 4 Aquilae	4.19	
	2,	1.1	θ Serpentis 2 N 8 4 Aquilae	4.29	
	3,	1.9	θ Serpentis 6 N 4 4 Aquilae	4.66	
			β Scuti 7 N 3 4 Aquilae	4.87	
			70 Ophiuchi 4 N 6 27 Aquilae	4.63	
			N 3 4 Aquilae 7 64 Serpentis	4.78	
	4.	1.6	θ Serpentis 8 N 2 4 Aquilae	4.85	
			β Scuti 5 N 5 η Scuti	4.76	
			12 Aquilae 5 N 5 η Scuti	4.60	
			N 1 4 Aquilae 9 P.G.C. 4719	4.96	
			β Scuti 3 N 7 21 Aquilae	4.66	
		23.6	θ Serpentis 6 N 4 4 Aquilae	4.66	
			β Scuti 3 N 7 η Scuti	4.64	
			α Scuti 4 N 6 21 Aquilae	4.48	
	5,	2.5	β Scuti 2 N 8 η Scuti	4.58	
	8,	23.0	N 2 θ Serpentis 8 4 Aquilae	3.86	
			η Serpentis 9 N 1 θ Serpentis	4.03	
			η Serpentis 7 N 3 β Scuti	4.16	
			η Serpentis 9 N 1 α Scuti	4.00	
			λ Aquilae 7 N 3 12 Aquilae	3.97	
	9,	1.2	η Serpentis 8 N 2 α Scuti	3.93	
	10,	23.0	N 2 θ Serpentis 8 4 Aquilae	3.86	
			α Scuti 2 N 8 β Scuti	4.14	
			λ Aquilae 7 N 3 12 Aquilae	3.97	
	11,	2.3	α Scuti 4 N 6 β Scuti	4.22	
			λ Aquilae 7 N 3 12 Aquilae	3.97	
	12,	0.3	N 1 θ Serpentis 9 4 Aquilae	4.00	
			λ Aquilae 9 N 1 12 Aquilae	4.09	
			α Scuti 4 N 6 β Scuti	4.22	
	13,	3.1	θ Serpentis 2 N 8 4 Aquilae	4.29	Cloudy
	14,	23.2	θ Serpentis 7 N 3 4 Aquilae	4.76	Moon

		h		M	
Aug.	15,	23.3	θ Serpentis 7 N 3 4 Aquilae	4.76	
			β Scuti 4 N 6 η Scuti	4.70	
			12 Aquilae 6 N 4 η Scuti	4.68	
			β Scuti 6 N 4 4 Aquilae	4.81	
	16,	23.6	N 2 θ Serpentis 8 4 Aquliae	3 86	Moon
			α Scuti 3 N 7 β Scuti	4.18	
		23.8	α Scuti 9 N 1 β Scuti	4.43	
	19,	0.3	N 3 θ Serpentis 7 4 Aquilae	3.70	Cloudy
	22,	22.9	θ Serpentis 6 N 4 4 Aquilae	4.66	
			β Scuti 4 N 6 η Scuti	4.70	
		23.8	θ Serpentis 7 N 3 4 Aquilae	4.76	
			β Scuti 5 N 5 η Scuti	4.75	
	23,	22.9	θ Serpentis 7 N 3 4 Aquilae	4.76	
	24.	23.6	θ Serpentis 6 N 4 4 Aquilae	4.66	
			β Scuti 4 N 6 η Scuti	4 70	
	25,	23.1	θ Serpentis 6 N 4 4 Aquilae	4.66	
			θ Serpentis 5 N 5 4 Aquilae	4.57	
			β Scuti 3 N 7 η Scuti	4.64	
			12 Aquilae 4 N 6 η Scuti	4 51	
	26,	23.8	N=θ Serpentis	4.10	
			α Scuti 4 N 6 β Scuti	4.22	
			N 1 θ Serpentis 9 4 Aquilae	4.00	
	27,	23.2	N=θ Serpentis	4.10	
			α Scuti 5 N 5 β Scuti	4.27	
	29,	23.0	N=θ Serpentis	4.10	
			α Scuti 7 N 3 β Scuti	4.35	
		23.2	θ Serpentis 1 N 9 4 Aquilae	4 19	
			α Scuti 6 N 4 β Scuti	4.31	
	30,	23.8	θ Serpentis 8 N 2 4 Aquilae	4.85	
			β Scuti 6 N 4 η Scuti	4.81	
			β Scuti 7 N 3 4 Aquilae	4.87	
	31,	22.6	θ S rpentis 9 N 1 4 Aquilae	4.95	
			β Scuti 8 N 2 η Scuti	4 93	
			θ Serpentis 4 N 6 5 Aquilae	4 73	
Sept.	1,	1.3	θ Serpentis 9 4 Aquilae 1 N	5.14	
			β Scuti 9 N 1 η Scuti	4.98	
		23.2	θ Serpentis 9 N 1 4 Aquilae	4.95	
			β Scuti 7 N 3 η Scuti	4.87	
	2,	23.4	θ Serpentis 9 N 1 4 Aquilae	4.95	
			β Scuti 6 N 4 η Scuti	4.81	
	3,	22.5	θ Serpentis 8 N 2 4 Aquilae	4.85	
			β Scuti 5 N 5 η Scuti	4 76	
			θ Serpentis 2 N 8 5 Aquilae	4 41	
	4,	0.0	θ Serpentis 9 N 1 4 Aquilae	4.95	
		22.7	θ Serpentis 8 N 2 4 Aquilae	4.85	
			β Scuti 5 N 5 η Scuti	4 76	
			12 Aquilae 5 N 5 η Scuti	4.60	
	5	22.5	θ Serpentis 4 N 6 4 Aquilae	4.48	

		h		M	
Sept.	5,	22.5	β Scuti 1 N 9 η Scuti	4.53	
			α Scuti 5 N 5 η Scuti	4.55	
			β Scuti 3 N 7 4 Aquilae	4.64	
	6,	22.4	θ Serpentis 1 N 9 4 Aquilae	4.19	
			α Scuti 4 N 6 η Scuti	4.45	
			β Scuti 2 N 8 η Scuti	4.58	
	8,	23.1	θ Serpentis 8 N 2 4 Aquilae	4.85	
			β Scuti 6 N 4 η Scuti	4.81	
			12 Aquilae 6 N 4 15 Aquilae	4.98	
	10,	0.0	θ Serpentis 9 4 Aquilae 1 N	5.14	
			β Scuti 8 N 2 η Scuti	4.93	
			θ Serpentis 9 N 1 4 Aquilae	4.95	2.6 cm Telescope
		22.4	θ Serpentis 8 N 2 4 Aquilae	4.85	
			β Scuti 6 N 4 η Scuti	4.81	
			N=4 Aquilae	5.04	
	11,	23.8	N=4 Aquilae	5.04	Cloudy
			β Scuti 7 N 3 η Scuti	4.87	
	14,	22.3	N=4 Aquilae	5.04	Moon
			β Scuti 7 N 3 η Scuti	4.87	
	15,	23.2	N=4 Aquilae	5.04	Moon
			β Scuti 7 N 3 η Scuti	4.87	
	19,	23.4	θ Serpentis 8 4 Aquilae 2 N	5.27	Full Moon
			β Scuti 9 N 1 η Scuti	4.98	
	21,	22.1	β Scuti 7 N 3 η Scuti	4.87	} at Osaka
			θ Serpentis 9 N 1 4 Aquilae	4.95	
	23,	23.8	θ Serpentis 8 4 Aquilae 2 N	5.27	
			β Scuti 9 N 1 η Scuti	4.98	
			4 Aquilae 3 N 7 P.G.C. 4719	5.27	
			4 Aquilae 3 N 7 5 Aquilae	5.23	
	24,	22.2	θ Serpentis 8 4 Aquilae 2 N	5.27	
			β Scuti 8 N 2 η Scuti	4.93	
			4 Aqutlae 2 N 8 P.G.C. 4719	5.19	
	25,	22.3	θ Serpentis 7 4 Aquilae 3 N	5.44	
			N=η Scuti	5.04	
			4 Aquilae 3 N 7 P.G.C. 4719	5.27	
			4 Aquilae 4 N 6 5 Aquilae	5.30	
Oct.	1,	22.8	θ Serpentis 8 N 2 4 Aquilae	4.85	
	8,	22.2	0 Serpentis 7 4 Aquilae 3 N	5.44	
			4 Aquilae 5 N 5 5 Aquilae	5.36	
			4 Aquilae 4 N 6 P.G.C. 4719	5.34	
			β Scuti 9 η Scuti 1 N	5.10	
			4 Aquilae 3 N 7 64 Serpentis	5.22	
	10,	22.3	θ Serpentis 9 4 Aquilae 1 N	5.14	Moon
			4 Aquilae 5 N 5 5 Aquilae	5.36	
			4 Aquilae 4 N 6 P.G.C. 4719	5.34	
			N=4 Aquilae	5.04	
	12,	0.8	θ Serpentis 9 4 Aquilae 1 N	5.14	(?)
		21.6	4 Aquilae 2 N 8 5 Aquilae	5.17	Moon

		h		M	
Oct.	12,	21.6	4 Aquilae 3 N 7 P.G.C. 4719	5.27	
			β Scuti 8 η Scuti 2 N	5.18	
	13,	21.8	4 Aquilae 7 N 3 P.G.C. 4719	5.57	Moon
			4 Aquilae 4 N 6 5 Aquilae	5.30	
			θ Serpentis 7 4 Aquilae 3 N	5.44	
			4 Aquilae 5 N 5 P.G.C. 4719	5.42	
	16,	21.4	θ Serpentis 7 4 Aquilae 3 N	5.44	Moon
			4 Aquilae 6 N 4 P.G.C. 4719	5.50	
			4 Aquilae 4 N 6 5 Aquilae	5.30	
			4 Aquilae 2 N 8 64 Serpentis	5.16	
		21.8	4 Aquilae 3 N 7 64 Serpentis	5.22	
	17,	22.4	θ Serpentis 7 4 Aquilae 3 N	5.44	
			4 Aquilae 6 N 4 P.G.C. 4719	5.50	
			4 Aquilae 4 N 6 5 Aquilae	5.30	
	18,	23.2	θ Serpentis 7 4 Aquilae 3 N	5.44	} at Osaka
			4 Aquilae 6 N 4 P.G.C. 4719	5.50	
	19,	22.7	θ Serpentis 6 4 Aquilae 4 N	5.67	at Osaka
	20,	21.6	θ Serpentis 6 4 Aquilae 4 N	5.67	
			4 Aquilae 6 N 4 P.G.C. 4719	5.50	
			4 Aquilae 5 N 5 5 Aquilae	5.36	
	21,	22.0	4 Aquilae 6 N 4 5 Aquilae	5.42	
			4 Aquilae 5 N 5 P.G.C. 4719	5.42	
			4 Aquilae 3 N 7 64 Serpentis	5.22	
	24,	21.5	4 Aquilae 7 N 3 5 Aquilae	5.49	
			4 Aquilae 8 N 2 P.G.C. 4719	5.65	
	26,	21.5	4 Aquilae 9 N 1 P.G.C. 4719	5.72	
			4 Aquilae 8 N 2 5 Aquilae	5.55	
			4 Aquilae 7 N 3 64 Serpentis	5.47	
	27,	21.4	4 Aquilae 9 N 1 P.G.C. 4719	5.72	
			4 Aquilae 9 N 1 5 Aquilae	5.62	
			4 Aquilae 8 N 2 64 Serpentis	5.53	
		22.0	N=P.G.C. 4719	5.80	(?)
	30,	21.8	N=P.G.C. 4719	5.80	
			4 Aquilae 9 N 1 5 Aquilae	5.62	
			4 Aquilae 8 N 2 64 Serpentis	5.53	
Nov.	2,	21.5	N=P.G.C. 4719	5.80	
			N=5 Aquilae	5.68	
			4 Aquilae 9 N 1 5 Aquilae	5.62	
	5,	23.2	4 Aquilae 9 P.G.C. 4719 1 N	5.88	
			N=P.G.C. 4719	5.80	
			4 Aquilae 9 N 1 64 Serpentis	5.59	
			4 Aquilae 9 N 1 5 Aquilae	5.62	
	6,	22.0	4 Aquilae 9 N 1 P.G.C. 4719	5.72	
			N=5 Aquilae	5.68	
	7,	22.0	4 Aquilae 9 P.G.C. 4719 1 N	5.88	Moon
			N=64 Serpentis	5.65	
			4 Aquilae 9 5 Aquilae 1 N	5.75	
	9,	21.5	4 Aquilae 8 P.G.C. 4719 2 N	5.99	

		h		M	
Nov.	9,	21.5	4 Aquilae 9 5 Aquilae 1 N	5.75	
	10,	21.7	4 Aquilae 9 P.G.C. 4719 1 N	5.88	
			4 Aquilae 9 5 Aquilae 1 N	5.75	
	11,	21.8	4 Aquilae 9 P.G.C. 4719 1 N	5.88	
			4 Aquilae 9 5 Aquilae 1 N	5.75	
	18,	22.0	4 Aquilae 9 P.G.C. 4719 1 N	5.88	
	19,	21.2	4 Aquilae 9 5 Aquilae 1 N	5.75	
			N=P.G.C. 4719	5.80	
Dec.	6,	21.4	N=ϵ Serpentis	5.80	
			5 Aquilae 1 N 9 BD+0° 4027	5.74	
1919 Feb.	5,	8.3	5 Aquilae 4 N 6 BD+0° 4027	5.91	Clear
			ϵ Serpentis 1 N 9 BD+0° 4027	5.85	
			4 Aquilae 8 ϵ Serpentis 2 N	5.99	
			ϵ Serpentis 3 N 7 61 Serpentis	5.80	
Mar.	5,	8.3	5 Aquilae 8 N 2 BD+0° 4027	6.14	
			61 Serpentis 5 N 5 BD+0° 4027	6.04	
Apr.	12,	7.2	N=or a little>BD+0° 4027	6.20	Clear
	25,	7.1	a little<BD+0° 4027	6.3	Clear; 2.6 cm Telescope
	26,	4.7	BD+0° 4027 2 N 8 BD−0° 3543	6.37	

It is with very great gratitude that we introduce here two more observers, Messrs. T. Sasaki and R. Furukawa, who have each been keeping the Nova under observation during the same period, and each have kindly communicated to us valuable data.

4) T. Sasaki's Estimations.

Mr. Sasaki is a school teacher living in Iwate Prefecture, (the International Latitude Observatory of Mizusawa is in the same region). His observations were made, generally, with a pair of binoculars, except in the early part which have been with the naked eye. The reductions were made by Kudara in the Harvard system.

Date	Gr. M. T.		Estimation	Magnitude	Remarks
		h		M	
1918 June	18,	2.0	α Ophiuchi 1 N 3 α Aquilae	1.83	
	26,	1.2	β Ophiuchi 1 N 1 δ Aquilae	3.19	Moon
		23.7	θ Serpentis 1 N 1 η Serpentis	3.76	
July	1,	23.3	ζ Aquilae 1 N 1 η Serpentis	3.22	
	2,	23.7	α Ophiuchi 2.5 N 1 η Serpentis	3.05	thru Stratus
	8,	23.8	θ Serpentis 2 N 1 η Serpentis	3.65	
	9,	1.4	θ Serpentis 1.5 N 1 δ Aquilae	3.70	
	10,	2.3	θ Serpentis 1 N 1 η Serpentis	3.76	
	24,	1.0	θ Serpentis 1 N 2 η Serpentis	3.87	thru Cirrus
		23.2	θ Serpentis 1 N 2 η Serpentis	3.87	
	26,	23.2	θ Serpentis 1 N 1.5 η Serpentis	3.83	
	27,	23.0	θ Serpentis 1 N 2 η Serpentis	3.87	

		h		M	
July	27,	23.0	4 Aquilae 3 N 1 λ Aquilae	3.92	
	28,	0.5	θ Serpentis 1 N 1.5 η Serpentis	3.83	
			4 Aquilae 3 N 1 δ Aquilae	3.84	
		1.5	θ Serpentis 1 N 2 η Serpentis	3.87	Moon
			θ Serpentis 1 N 1 λ Aquilae	3.83	
		23.3	θ Serpentis 1 N 1 η Serpentis	3.76	
	29,	0.1	θ Serpentis 1 N 1 δ Aquilae	3.77	
			α Scuti 1 N 2 ζ Aquilae	3.71	
			4 Aquilae 3 N 1 λ Aquilae	3.92	
		1.5	α Scuti 1 N 1.5 η Serpentis	3.80	Binoculars hereafter
		23.1	θ Serpentis 1 N 2 η Serpentis	3.87	
			4 Aquilae 3 N 1 δ Aquilae	3.84	
			4 Aquilae 2.5 N 1 λ Aquilae	3.98	
	30,	0.5	4 Aquilae 2.5 N 1 λ Aquilae	3.98	
			θ Serpentis 1 N 2.5 η Serpentis	3.91	
			δ Aquilae 1 N 1 β Scuti	3.96	
Aug.	30,	22.4	6 Scuti 1 N 1 4 Aquilae	4.75	
			θ Serpentis 1 N 1.5 5 Aquilae	4.73	
	31,	0.3	6 Scuti 1.5 N 1 4 Aquilae	4.81	
			12 Aquilae 1 N 1 5 Aquilae	4.91	
			ι Aquilae 1 N 1.5 5 Aquilae	4.84	
Sept.	4,	23.1	12 Aquilae 1 N 2 4 Aquilae	4.45	
			6 Scuti 1 N 2.5 5 Aquilae	4.82	
	9,	22.8	6 Scuti 2 N 1 4 Aquilae	4.85	
			δ Aquilae 2.5 N 1 5 Aquilae	5.04	
	11,	0.8	4 Aquilae 1 N 1.5 6 Scuti	4.81	
			4 Aquilae 1 N 2.5 12 Aquilae	4.79	
			5 Aquilae 1 N 3 δ Aquilae	5.12	
		23.7	4 Aquilae 1 N 2 6 Scuti	4.85	
			5 Aquilae 1 N 1.5 12 Aquilae	5.07	
Oct.	1,	23.8	5 Aquilae 1 N 2 12 Aquilae	5.17	
			4 Aquilae 1 N 2 6 Scuti	4.85	
	3,	23.4	4 Aquilae 1 N 2 6 Scuti	4.85	
			5 Aquilae 1 N 2.5 12 Aquilae	5.24	
	7,	22.4	5 Aquilae 1.5 N 1 4 Aquilae	5.30	
			5 Aquilae 1 N 3 6 Scuti	5.38	
	8,	22.4	4 Aquilae=N	5.04	
			5 Aquilae 1 N 2.5 6 Scuti	5.33	
	9,	23.0	4 Aquilae 1 N 3 8 Aquilae	5.29	
Nov.	3,	21.8	4 Aquilae 1 N 2 P.G.C. 4845.	5.27	
	28,	21.6	5 Aquilae 1 N 2 H.R. 7245	5.93	

5) R. Furukawa's Estimations.

Mr. Furukawa is an assistant in the Kamigamo Geophysical Observatory (some 4 kilometers to the north) of Kyoto University. His observations were made with the naked eye.

Date	Gr. M. T.	Estimation	Magnitude M	Remarks
	h			
1918 June	14, 4.0	Vega 4 N 6 Ophiuchi	0.94	
		Altair 1 N 9 α Ophiuchi	1.02	
	21, 2 4	Vega 7 N 3 β Cygni	2.21	
		Altair 5 N 5 δ Aquilae	2.17	
		α Ophiuchi 9 N 1 ε Cygni	2.59	
		γ Cygni 5 N 5 ε Cygni	2.48	
		Altair 6 N 4 ζ Aquilae	2.17	
July	1, 3	N=η Serpentis	3.42	
	4.7	ζ Aquilae 3 N 7 λ Aquilae	3.18	
		β Ophiuchi 7 N 3 η Serpentis	3.28	
	9, 0.5	η Serpentis 3 N 7 θ Serpentis	3.62	
		ζ Aquilae 4 N 6 ε Aquilae	3.50	
	27, 23.5	η Serpentis 4 N 6 θ Serpentis	3.69	
		γ Aquilae 8 N 2 β Aquilae	3.68	
Aug.	1, 0.0	δ Aquilae 5 N 5 4 Aquilae	4.24	
		ζ Aquilae 8 N 2 θ Serpentis	3.88	
	2, 0.0	δ Aquilae 6 N 4 4 Aquilae	4 40	
		ι Aquilae 2 N 8 β Scuti	4.32	
	3, 0.0	δ Aquilae 7 N 3 4 Aquilae	4.56	
		θ Serpentis 1 N 9 64 Serpentis	4.26	
	23.8	ι Aquilae 2 N 8 4 Aquilae	4.43	
		θ Serpentis 1 N 9 64 Serpentis	4.26	
	8, 23.7	ι Aquilae 1 N 9 64 Serpentis	4.42	
		ι Aquilae 6 N 4 θ Serpentis	4.17	
		β Aquilae 4 N 6 4 Aquilae	4.36	

In a former paper in these Memoirs,[1] one of the writers (I.Y.) obtained a provisional light-curve of the Nova, to which the observational data of the first four persons were contributed, while those of Mr. Furukawa were received too late.

A more or less definite light-curve will shortly be published, in which all materials of foreign and home observers, available to us, are to be used.

(ii) Mean Place of Nova Aquilae, No. 3.

The meridian observations of the Nova to obtain accurate positions were made, exclusively, by Kudara, who made the laborious computations and reductions, too.

Right Ascension. The right ascensions were determined by transit observations with a portable instrument (aperture 6 cm.) relative to the neighboring fundamental stars as mentioned below, whose mean places were obtained from the Washington Ephemeris. The results are as follows:

1 Vol. IV, No. 1, pp. 13–22. (1919).

Date of observation	Epoch	Observed R. A. at (1918.0)	Weight	Fundamental Stars, &c.
1918 June 13	1918.45	h m s 18 44 43.59	1	Vega, ε Aquilae, π Sagittarii, δ Draconis, δ Aquilae.
„ „ 21	1918.47	43.32	½	c Serpentis, Vega. (thru passing clouds.)
Mean:	1918.454	h m s 18 43 43.52	(1918.0)	

Declination. The Declinations were determined differentially with the micrometer of another portable transit instrument (aperture 6.5 cm.) belonging to the National Geodetic Committee, relative to the near stars. The results are:

Date of observation	Epoch	Observed Decl. for (1918.0)	Weight	Comparison-stars, &c.
1918 June 30	1918.49	+0° 29′ 30.″34	⅖	Brad. 2431, Boss P.G.C. Place.
„ July 1	.50	30.68	1	„ „ „ „ „
„ „ 2	.50	30.47	⅘	η Aquilae, Am. Eph. Place.
Mean:	1918.497	+0° 29′ 30.″54	(1918.0)	

Another series of declinations were obtained by Kudara, who observed the differential zenith-distances of σ Draconis and the Nova, reversing the Horrebow-Talcott Method, and using the latter instrument above mentioned. These observations, also with the former series of declination, were made in a room whose main part was specially designed to be easily removed, if necessary, to a distance, instead of opening the roof as usual, so that the actual observation could be made *in the open air*, the instrument standing on a pillar in the centre of the floor remaining unaccompanied by the removed parts. In these observations and reductions the observer provisionarily assumed the latitude of the pillar obtained by triangulation between it and the Meridian Room, whose latitude was known, and finally obtained:

Date of observation	Epoch	Observed Decl. for (1918.0)	Weight	Remarks
1918 June 30	1918.49	+0° 29′ 30.″98	⅖	Boss P.G.C. Place, cloudy.
„ July 1	1918.50	30.89	1	„ „ „ , fine.
Mean:	1918.50	+0° 29′ 30.″92	(1918.0)	

The systematic difference between the above two series of declinations is of some significance. Four kinds of causes are here to be considered, i. e.:

(1) Adopted mean place of σ Draconis, which is, in fact, one of the nearest stars and has a very large Proper Motion;

(2) Latitude Variation, the amount of which is now unknown, but may be small even in full amplitude in these days;

(3) Error in the differential latitude obtained by triangulations, which may, however, be of no considerable amount;

(4) Anomalies in the atmospheric refraction affecting in different manners each of the two rooms.

Of these, the combined effect of (1) and (3) might not amount to $0''.1$. The effective amplitude of the Latitude Variation is unknown; it is, however, probable, judging from an exterpolation of the variation-curve known up to these days, that this amount may be about $0''.10$, almost certainly not exceeding $0''.2$. The last effect will be promising to a certain extent, and a special programme of observational examinations is in the course of execution. Prof. S. Shinjo, some years ago, discussed a similar problem from the theoretical standpoint in a paper on the "z"-term of the Latitude Variations, and reached a conclusion with which the above obtained difference of declinations and its sense should agree. (See Memoirs Coll. Sc. & Eng. Kyoto Imp. Univ., vol. IV, No, 2, 1912.)

(iii) Spectra of the Nova.

In the interval of a little less than a month from the first outburst of the Nova, we obtained 24 plates of the spectra with an objective-prism of aperture 18 cm. attached to an equatorial. The dispersion was such that the distance between $H\beta$ and $H\delta$ was 6.0 mm. The first four plates Nos. 301 to 304 were secured by Prof. M. Matuyama and Kudara during the absence of two of the writers, while the other plates were obtained mainly by Yamamoto and Ueta. The measurements and reductions were, however, done, exclusively, by Yamamoto. Most of the plates used in this work were the Ilford Special Rapid plates, but several times those which were sensitive to red light were used through the kindness of Prof. M. Kimura of the Physical Institute. Approximate wave-lengths were obtained by the Hartmann-Cornu formula, assuming the centres of bright $H\alpha$, $H\beta$, $H\gamma$, and $H\delta$ as standards.

June 14, Plate 301, taken at 11.6[h] (Local Mean Time[1])
" 302, " " 12.3 "
" 303, " " 12.9 "
" 304, " " 13,2 "

In these plates the guidings and the focus were not very good, which are much to be regretted in view of the great activity of the Nova. Yet, we may, to some extent, get a general idea of the apparition through these plates. The continuous spectrum is fairly strong and extends very far to the ultraviolet: the total lengths of the spectra on the plates are some 11 mm. long, the least refrangible limit being at about 5030 A. On these grounds, the bright hydrogen lines (bands) are most intense, of which four lines are clearly seen, each having a trace of dark absorption on its violet side. Plate 301 is faint, but in Plates 302–304 we see many other complexities of brightenings and darkenings. Beyond Hβ, two maxima λ 5016 and λ 4920 are seen, while between Hβ and Hγ there are at least two brightenings, of which the less refrangible one corresponds to λ 463 which is sharply bordered by an absorption on its violet side, the other is a little broad and diffuse and might correspond to Helium λ 4472. Two more brightenings are suspected between Hγ and Hδ.

June 28, at 10[h] (Local Mean Time), only one plate, No. 305, was taken, which was, however, very ill guided and several exposures were superposed upon each other; hence a very rough survey only can be allowed. In this the continuous spectrum is not strong relatively to line-emissions, of which only four are visible, each being very strong and sharp This appearance just corresponds and, at the same time, justifies the minimum phase in the light-curve. Of emissions, the three are Hβ, Hγ, and Hδ, while the remaining one is λ 4639 whose sharpness is just like the other members; this should rather be a peculiar fact, for its usual appearances are particularly broad as may be seen in the following. The intensity of λ 4639 is almost equal to that of Hγ. Hε is faintly glimpsed probably because of being out of focus. One more emission λ 4485 is suspected.

---

1 9[h] 3[m] earlier than Greenw. M.T.

July 1, Plate 306, at 14^h (L.M.T.)
" 307, " " "
" 308, " " "
" 309, " " " Wratten-W. Panchrom. Plate.
" 310, " 15 " Ilford Red-Sensitive Plate.
" 311, " " " " " " "
" 312, " " "

On four ordinary (Ilford Special Rapid) plates, we see a well-developed spectrum of Nova. Now the bright lines are most characteristic in their broadness and intensity. Not a dark absorption is perceptible, which was an indispensable accompaniment to each of the line-emissions on our first day. Five members of hydrogen are seen, Hβ being the most strong. The structure of λ4635 is interesting: its maximum intensity is a little stronger than Hδ, but its width is quite astonishing. There are double grades of blackening on the plates: the widest limits include an interval of about 154 Å, on which a more intense band of the width of ca. 55 Å is centrally placed, the maximum intensity being on their common center. See the accompanying diagram. Other emissions in Plate 306 are:

λ5016	Helium line, intensity equals Hδ.
492	very weak, weaker than Hε.
470	only suspected, broad.
4471	Helium line, broad and diffuse.
428	broad and faint.

An absorption at 4059 is glimpsed.

General features of the Plates 307, 308, and 312 are the same as in the preceding, except that an emission at λ441 is suspected on Pl. 307.

Panchromatic and Red-Sensitive plates were equally under-exposed, on which, therefore, only six spots are impressed corresponding to Hα, Hβ, λ463, λ447, Hγ, and Hδ.

July 2, Plate 313, at 14^h (L.M.T.)
" 314. " " "

The continuous background is a little more intense, and considerably developed toward the ultraviolet. Hydrogen lines are bright and strong, of which five members, Hβ to Hζ are seen

(Hβ being the brightest), and *not* appended by dark components. Beyond Hδ is generally diffuse, probably because of λ 4059. And a definite absorption is found between Hε and Hζ, corresponding to the wave-length λ 394.

Following emissions are found, besides,

λ 5016	Helium line, clear and definite.
4910	faint.
483	faint and diffuse.
4636	very broad and peculiar, see below.
4519	very faint.
4471	Helium line, diffuse.
4254	diffuse.

The band 4636 is again peculiar. Its extraordinary broad range, amounting to about 159 Å, occupies more than a quarter of the space between Hβ and Hγ. The central part of condensation is pretty sharp and strong.

July 3, $13^h\ 30.^m$ An Ilford Red-sensitive Plate, (No. 315), was exposed, but unfortunately the exposure was somewhat over-estimated. But a careful examination shows the following eight emission lines:

Ha,	Hβ,	λ 479,	λ 470,	λ 463,	λ 447,	Hγ, and	Hδ.
100	30	4	3	10	3	25	4

the second row being the respective intensities.

July 7, Plate 316, at $12^h.5$ (L.M T.) Fair Spectrum!
„ 317, „ 14.4 „
„ 318, „ 14.4 „
„ 319, „ 14.5 „

Moderate continuous spectrum upon which many bright and *dark* lines are clearly shown, Hδ being at the best focus. Ultraviolet extensions are again well demonstrated.

The intensities of the hydrogen lines are strong in general, of which Hβ is the most intense, gradually becoming weakened toward the violet; six in all, from Hβ to Hη, are easily visible. Amongst others, the Hδ shows the most delicate and complex structure in that the double grade brightenings are the typical kind of appearance: the wider, and therefore the weaker, emission

extends for a range of about 90 Å, while the narrower and stronger portion takes 45 Å in just the central part of the former kind. Every boundary is always sharp.

Other emission lines are:

λ 5016 faint,
4920 suspected, } weak because of out of focus.

4633 very broad and diffuse, intensity almost equals that of Hδ, attended by an absorption on its violet side. Width is about 151 Å, showing a central intensification probably due to the effect of the double-grade peculiarity.

455 diffuse.

4472 faint and diffuse.

400 fine emission.

299 weak and broad.

Moreover, at least the following three absorption lines are seen:

λ 4609 clear, this has been already mentioned in the notes on the emission λ 4633.

4059 very fine and strong, sharp on both sides.

3869 darkening between Hζ and Hη.

July 9, Plate 320, at $13^{h}.1$ (L.M.T.)
" 321, " 13.4 "
" 322, " " "
" 323, " 13.6 "
" 324, " " "

Good adjustments of the mechanical parts of the instrument furnished here the richest harvest of these spectroscopic results. The following descriptions are not sufficient for full details, which might be supplemented, to some extent, by the accompanying intensity-curves.

The continuous spectrum is moderate, whose most radiative efficiency lies in the region of Hγ. Hydrogen emissions are as intense as the preceding, intensities being highest in Hβ and gradually weakening toward the violet. The peculiar complexities in Hδ are generally the same as those on July 7; besides, a similar characteristic can be observed in each of the other members, Hβ and Hγ, in which, however, a close reproduction of Hδ cannot be expected, but the one-sided wings are seen.

Among other emissions are the following:

λ 5016, 4924 somewhat obscure.
4772 faint.
4635 very complex, showing several grades toward the central concentration; the widest limits include a range of about 163 Å; the central maximum scarcely exceeds Hδ in intensity.
4535
4471 broad and diffuse.
4385 faint
4286 faint
420 faint
4144 faint
4040 faint

Dark absorptions are:

4570 clear
4501
4470
4372
4305
421
4134
4060 strong and clear

General Remarks on Spectra.

It is clearly shown in these plates that the period covered by them is the "Bright-Line Stage" of the Nova, and that the Hydrogen emissions especially are the most active factors among others. Not only the intensities, but their widths are very great: the following values are the most probable means throughout the whole period, except the first day,

Hβ, width 83 Å
Hγ, „ 52 „
Hδ, „ 46 „

These great values may, possibly, not be explained, even if they should be real, unless we do not assume an extraordinary density and pressure prevailing in the stellar atmosphere.

The most enigmatical behavior of the broad emission band λ4635 is, rather, to be considered as "usual" in historical Novae, though its origin and the mechanism have not yet been delineated by any laboratory method. It seems, however, to us that some physical relations, or so to speak, analogies, would exist between it and the Wolf-Rayet blue bands λ4688 and λ4652, which were partly treated, some time ago, by A. Fowler to a great success of spectroscopy in its extraordinary instrumental arrangements. Helium and Hydrogen which play solely the active rôle in these stages of Novae must here also be connected with in a sense.

Helium shows a gradual development toward emission in this period of our observations, but always decidedly more weak and diffuse than Hydrogen, which suggests a transition to a more nebular stage.

The peculiar absorption 4059 gradually attained a well marked development toward our later dates, which have not yet been sufficient, however, to show its daily changes in full, owing to our lack of instrumental and meteorological conditions.

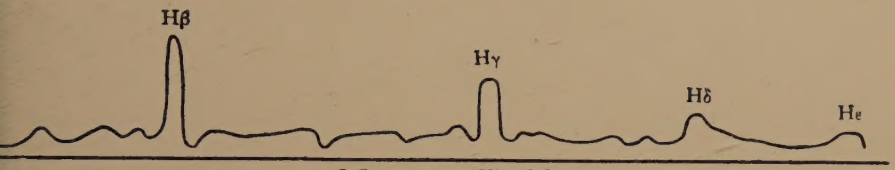
NOTES *to the accompanying Plate of Spectrographic Intensity-Curves of Nova Aquilae No. 3.*——The first of these were drawn by Prof. Matuyama and Kudara in the night of June 14, 1918, who looked through the telescope at the visual appearances of the objective-prism spectrum. The others were drawn by Yamamoto who examined carefully the photographic spectra on each plate and roughly estimated their relative intensities of blackening affected.

Hearty thanks are due to Prof. M. Matuyama, by whose collaboration our partial data were obtained; to Prof. M. Kimura, by whose kindness our spectroscopic work was enriched to a wider range; and to Professors S. Shinjo and T. Shida, under whose constant supervision the above results were freely reached.

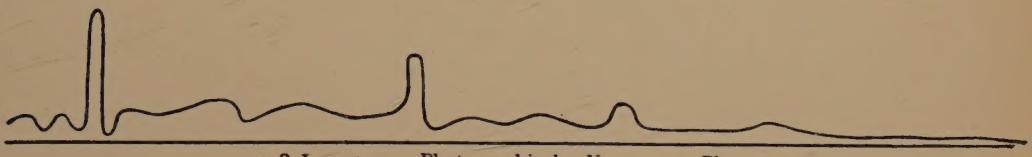
Imperial University Observatory, Kyoto.

April 28, 1919.

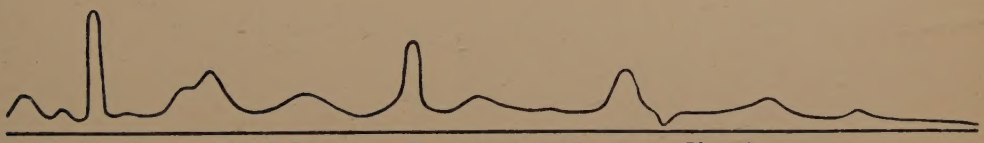
Plate I.



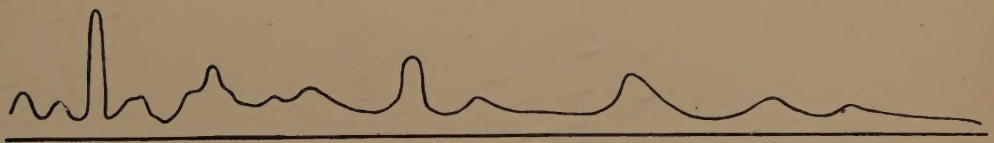
1918 June 14. Visual, by Matsuyama & Kudara.



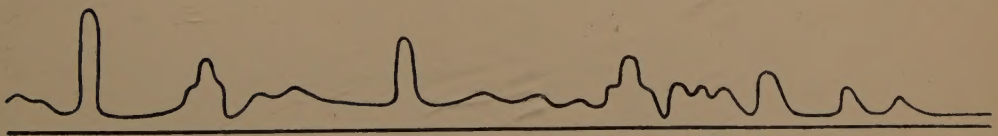
1918 June 14. Photographic, by Yamamoto, Pl. 302.



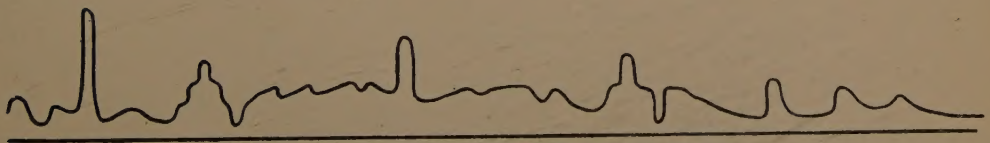
1918 July 1. Photographic, by Yamamoto, Pl. 306.



1918 July 2. Photographic, by Yamamoto, Pl. 313.



1918 July 7. Photographic, by Yamamoto, Pl. 316.



1918 July 9. Photographic, by Yamamoto, Pl. 324.

Plate II.

Spectra of the Nova Aquilae No. 3, taken with a 7-in Objective-Prism. (Enlarged to 5–6 times.)

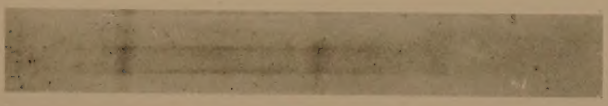


Fig. 1. June 14th. Pl. 302.

Fig. 2. July 2nd. Pl. 313.

Fig. 3. July 7th. Pl. 318.

Fig. 4. July 9th. Pl. 324.

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